OVERHAUL MAIN PROPULSION GENERATORS AND MOTORS

1. SCOPE

1.1 Scope. This standard specification describes the requirements for overhauling main propulsion generators and motors onboard Coast Guard vessels.

1.2 Alternate terminology. The term "machine", when used in this specification, shall imply generators or motors.

1.3 Appendices. The following appendices are part of this standard specification:

TITLE	APPENDIX
Clean, Inspect, and Test Main Propulsion Generators and Motors	A
Repair Main Propulsion Generator and Motor Insulation	B
Rebuild Main Propulsion Generator and Motor Commutators	C
Rewind Main Propulsion Generator and Motor Armatures	D
Rewind Main Propulsion Generator and Motor Main Field Windings	E

2. APPLICABLE DOCUMENTS

Commercial Item Description (CID) A-A-52084, Jun 2003, Tape, Lacing and Tying

Commercial Item Description (CID) A-A-58052, Apr 96, Stone, Commutator Burnishing (Flexible Abrasive)

MIL-Y-1140, Sep 1985, Yarn, Cord, Sleeving, Cloth and Tape-Glass

MIL-I-3190, Aug 1993, Insulation Sleeving, Electrical, Flexible, Coated, General Specification for

DOD-STD-2188, Apr 1987, Babbitting of Bearing Shells

MIL-I-15126, Apr 2003, Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive

MIL-DTL-16878, Aug 2000, Wire, Electrical, Insulated, General Specification for

MIL-D-16791, Jan 1993, Detergents, General Purpose (liquid non-ionic)

MIL-I-19166, Oct 1988, Insulation Tape, Electrical, High Temperature, Glass Fiber, Pressure Sensitive

MIL-I-24092, Sep 1993, Insulating Resin, Solventless, Baking, Flexible for Dip Processing, Grade SF, Class 130 to 180 Thermal Class

MIL-I-24178, Oct 1988, Insulation Tape, Electrical, Semi-cured Thermosetting Resin Treated Glass, Armature Banding, Naval Shipboard

MIL-I-24718, Jun 1993, Insulation Resins, Solventless, Vacuum-Pressure-Impregnation; General Specification for

MIL-I-24768, Dec 1992, Insulation, Plastics, Laminated, Thermosetting; General Specification for

MIL-I-24768/1, Dec 1992, Insulation, Plastics, Laminated, Thermosetting, General Specification for

MIL-I-24768/17, Feb 1992, Insulation, Plastic, Laminated, Thermosetting, Glass Cloth, Silicone Resin

Coast Guard Maintenance and Logistics Command Atlantic (MLCA), Standard Specification 0740_STD, 2004 Edition, Welding and Allied Processes

National Electrical Manufacturers Association (NEMA) FI-3, 1999, Calendered Aramid Papers Used For Electrical Insulation

Naval Ships' Technical Manual (NSTM), Chapter 235, Sep 1999, Electric Propulsion Installation

Naval Ships' Technical Manual (NSTM), Chapter 244, May 2002, Propulsion Bearings and Seals

Naval Ships' Technical Manual (NSTM) Chapter 300, Dec 2000, Electric Plant - General

American Society for Testing and Materials (ASTM) B177, 2001, Standard Guide for Chromium Electroplating on Steel for Engineering Use

American Society for Testing and Materials (ASTM) B272, 2002, Standard Specification for Copper Flat Products with Finished (Rolled or drawn) Edges (Flat Wire and Strip)

American Society For Testing and Materials (ASTM) D352, 2003, Standard Test Methods for Pasted Mica, Used in Electrical Insulation

American Society for Testing and Materials (ASTM) D3951, 1998, Standard Practice for Commercial Packaging

American Society for Testing and Materials (ASTM) E114, Reapproved 2001, Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method

American Society for Testing and Materials (ASTM) E165, 2002, Standard Test Method for Liquid Penetrant Examination

American Society for Testing and Materials (ASTM) E587, 2000, Standard Practice for Ultrasonic Angle-Beam Examination by the Contact Method

American Society for Testing and Materials (ASTM) E709, 2001, Standard Guide for Magnetic Particle Examination

American Society for Testing and Materials (ASTM) E1417, 1999, Standard Practice for Liquid Penetrant Examination

American Society for Testing and Materials (ASTM) E1444, 2001, Standard Practice for Magnetic Particle Examination

National Electrical Manufacturers Association (NEMA) MW-1000, 2003, Magnet Wire

National Electrical Manufacturers Association (NEMA) MG 1, 2002, Motors and Generators

Society of Automotive Engineers (SAE), AMS4800, 1992, Bearings, Babbit

3. REQUIREMENTS

3.1 General. The Contractor shall perform the particular overhaul task(s) specified in the work item, in accordance with this standard specification and the applicable appendix(ces) herein.

3.1.1 Inspection and test notification and documentation. The Contractor shall abide by the following rules for all inspections and tests specified herein.

3.1.1.1 Advance notice. Notify the Coast Guard Inspector at least 24 hours before performing each test and inspection.

3.1.1.2 Documentation. Submit a CFR upon completion of each inspection and test, in addition to a copy of completed test data sheet.

3.1.2 Removal. The Contractor shall remove the applicable components from the vessel and package them for delivery to and from the repair facility, in accordance ASTM D3951.

3.2 Preliminary measurements. The Contractor shall accomplish the following, prior to removal of the machine:

3.2.1 Coupling and alignment clearances. Measure and record the coupling and alignment clearances.

3.2.2 Air gap clearances. Measure all main pole and interpole air gap clearances as follows, ensuring that the amount of removed varnish is kept to a minimum, and varnish residuals from the iron on the pole and the iron on the armature are removed, wherever measurements will be taken:

- Choose and non-destructively mark the centerline of each main pole on both ends (fore and aft), as well as a single point on each end of the armature.
- Align the mark on the armature with the mark on the number one main pole (arbitrarily chosen). Carefully measure the air gaps with a tapered feeler gauge to the nearest thousandth of an inch; record the readings in the "Main Pole" section, "A" columns (Fore and Aft) of the DATA SHEET 1 (Air Gap Readings) provided herein.Rotate the armature until the mark on the armature is aligned with the mark on the number two main pole; measure the air gap for the number two main pole, fore and aft, and record the measurement on the data sheet.
- Repeat the above procedures, until the mark on the armature has been aligned with the marks on each of the remaining main poles.
- Measure the interpole air gaps, as specified above for the main poles; record the readings in the "Interpole" section, "A" columns (Fore and Aft) of the DATA SHEET 1 (Air Gap Readings) provided herein.

3.3 Reinstallation. Upon completion of all tests and inspections, the Contractor shall reinstall and restore equipment to original configuration, and accomplish the following:

3.3.1 Air gap clearance. Take air gap, coupling, and alignment readings; and make adjustments, as necessary, to obtain agreement (within plus or minus five percent) of the manufacturer's recommended air gap clearance. Record the air gap readings onto the applicable section of DATA SHEET 1 (Air Gap Readings), provided herein.

3.3.2 Electrical connections. Make electrical connections for cables 3/8-inch or greater in diameter with lug connectors of the two bolt-hole type.

3.3.3 Commutator film restoration. Restore the commutator film in accordance with NSTM Chapter 300, Section 300-4.7.8.7 (Restoring the Commutator Film).

3.4 Insulation materials. The Contractor shall refer to Table I below whenever insulation renewal is specified in an appendix:

TABLE I. INSULATION MATERIALS FOR RANDOM WINDINGS (Note 1)

ITEM	INSULATION CLASS MATERIALS (Notes 2,3,7)	
	F(155°C)	H(180°C) N(200°C)
Lead Wire	MIL-DTL-16878, EPDM	MIL-DTL-16878, PTFE or Silicone Rubber
Sleeving, leads and connections	MIL-I-3190, Class 155	MIL-I-3190, Class 200
Slot wedges, flat (Machine to shape)	MIL-DTL-24768/1, GME (Glass-Melamine)	MIL-I-24768/17, GSG
Varnish-solvent (Dip & Bake)	MIL-I-24092, Class 155 Grade CB Composition I	MIL-I-24092, Class 200 Silicone
Varnish-solvent (VPI only)	MIL-I-24718	MIL-I-24718
Armor tape	Dacron (Note 4)	MIL-Y-1140 (Untreated glass) (Note 6)
Adhesive tape	MIL-I-15126, Type gft	MIL-I-19166
Coil side separator	NEMA FI-3 (polyamide paper) or MIL-I-24768 (Glass)	
Varnish-solventless (dip & bake)	MIL-I-24092/5	
Slot wedges, U shape	NEMA FI-3 (polyamide paper)	
Band Insulation (Note 5)	MIL-I-24178 (glass tape, semi-cured)	
Magnet wire (Note 7)	NEMA MW-1000 (polyamide film coated)	
Slot insulation (slot cell)	NEMA FI-3 (polyamide paper)	
Phase insulation	NEMA FI-3 (polyamide paper)	
Lacing, tying cord	CID A-A-52084, Type V (aromatic polyamide)	

NOTES FROM TABLE I.

1. Random windings consist of ac motor stator and dc armatures.
2. See Appendix A, NSTM Chapter 300, for available sizes, types and grades.
3. For Class A, B and F insulation systems, use materials indicated for Class F materials.
4. Commercial grades, no applicable Government specification available.
5. Insulation material used under metallic bands.
6. Untreated glass must be given a VOLAN treatment to remove the starches and oils used in weaving.
7. When the OEM drawings specify a different wire type, and it is known that the insulation system has not been upgraded, or when the wire removed can be typed, that wire can be used in lieu of type M.

4. QUALITY ASSURANCE

4.1 Sea trials. Upon completion of overhaul and reinstallation, the Contractor shall conduct seal trials and demonstrate proper operation of the machine. While the machine is in operation, record all operating parameters for the loads and times specified in Table II below.

TABLE II. SEA TRIALS - MAIN PROPULSION GENERATOR AND MOTOR OPERATING PARAMETERS

LOAD (percent)	TIME (minutes)
25	120
35-85*	30*
95	60
100	30

***Apply a test load for the machine starting at 35% load through 85% load in 10% increments, 30 minutes for each 10 minute increment.**

5. NOTES

5.1 Machinery operation. The ship's force will operate all machinery during the sea trials and operational tests.

DATA SHEET 1. AIR GAP READINGS

VESSEL NAME: _____

HULL#:_____

POLE NO.	MAIN POLE				INTERPOLE			
	FORE		AFT		FORE		AFT	
	*A	**B	*A	**B	*A	**B	*A	**B
1								
2								
3								
4								
5								
6								
7								
8								

***Column A is for recording of preliminary air gap clearances.**
****Column B is for recording of post-installation air gap clearances.**

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test conductor			
USCG Inspector			
Ambient conditions:			

APPENDIX A

CLEAN, INSPECT, AND TEST MAIN PROPULSION GENERATORS AND MOTORS

10. SCOPE

10.1 Scope. This appendix describes the requirements for the Contractor to clean, inspect, and test main propulsion generators and motors.

20. REQUIREMENTS

20.1 Cleaning and inspection requirements. The Contractor shall accomplish the following:

20.1.1 Cleaning.

20.1.1.1 Armature and field winding. Clean the armatures and field windings as follows:

- Prepare a compound and water solution consisting of non-ionic type detergent conforming to MIL-D-16791, ensuring that the ratio of detergent to water is one pound of detergent to two-and-one-quarter gallons of water. Maintain the solution at 190 degrees Fahrenheit (88 degrees Celsius).
- Place the components in the cleaning solution. Ensure that the armature has its axis in the vertical position and the commutator end up.
- Circulate the solution through the windings and out through the commutator risers by stirring with an air agitator.
- Thoroughly flush the windings with clean hot water. Remove surface moisture with a dry clean cloth to minimize the amount of water that soaks into the insulation.
- Immediately after cleaning, rinsing and hand drying, thoroughly dry the windings in an oven for a minimum of eight hours. Refer to Table A-I below for the maximum allowable oven temperatures.

NOTICE!

Cleaning requires eight to ten hours depending on the condition and size of the armature.

TABLE A-I. MAXIMUM OVEN TEMPERATURES FOR DRYING WINDINGS

INTERVAL (hour)	MAXIMUM TEMPERATURE		SPECIAL INSTRUCTIONS
	Celsius	Fahrenheit	
0 to 1	75°	167°	Do not exceed the maximum temperature in the 1st hour.
1 to 8	105°	221°	Slowly increase oven temperature to reach the maximum.

20.1.1.2 Commutator. Clean the commutator using a canvas cloth while the machine is rotating. Clean the commutator slots, using a combination of suction and a small bristle brush; wipe commutator and adjacent parts with a clean, lint-free canvas or cheese cloth.

20.1.1.3 Brushes. Clean and polish the brushes, using a glass-bead blast. Dip the assembly in a sulfuric acid solution to be followed by a nitric acid solution to dissolve the newly formed oxides. Following dipping, thoroughly rinse and rapidly dry the brushes, to avoid tarnishing.

20.1.2 Inspections.

20.1.2.1 Armature and field windings. Perform a visual inspection of the cleaned windings.

20.1.2.2 Commutator. Perform the following inspection:

- Inspect commutator for signs of surface roughness, and for loose bars, high bars, movement of the mica, and cracked or broken risers.
- Record commutator diameter and eccentricity (if any).

20.1.2.3 Brushes. Perform a visual inspection of the cleaned brushes.

20.2 Post-cleaning tests. Upon completion of cleaning, the Contractor shall reassemble the armature and accomplish the tests specified below. Record required test data on a DATA SHEET 1 (Post-Cleaning Insulation Resistance Readings), provided herein.

20.2.1 Insulation resistance. Conduct an insulation resistance test, using a test voltage of 500 volts, for both commutator and armature. The minimum acceptable insulation resistance is 50 megohms, corrected to 77 degrees Fahrenheit (25 degrees Celsius).

20.2.2 Bar-to-bar. Apply a test voltage of 500 volts D.C. between adjacent bars, to determine if any short circuit exists between armature coils and from armature coils to the iron core.

20.3 Component repairs and renewal. When stated in the work item, or if a Change Request has been released and authorized by the KO, the Contractor shall:

20.3.1 Bearings rebabbitting. Rebabbit the bearings in accordance with DOD-STD-2088, as applicable, and measure new bearing clearance readings in accordance with NSTM Chapter 244, Section 244-2.6.9 (Bearing Clearance). Submit a written report to the COR within 48 hours after:

- Completion of bearing readings.
- Recording any abnormal vibration, noise, high torque, or excessively high temperature of the rebabbitted bearing during the sea trials.

20.3.2 Brush renewal. Furnish and install new brushes into the brush rigging assembly.

20.3.2.1 Turn the commutator in the normal direction to achieve a brush contact to within 95 percent of full contact.

20.3.2.2 After the brushes have been installed, check and ensure the following:

- Brushes are free to move in the brush holder without sticking.
- Brush tension is adjusted to approximately 2-1/2 pounds per square inch of brush cross section area.
- The shunt terminals are firmly attached to the brush holders.

30. QUALITY ASSURANCE

No additional requirements.

40. NOTES

This section is not applicable to this appendix.

DATA SHEET A-1. POST-INSULATION RESISTANCE READINGS

VESSEL INFORMATION
NAME: _____
HULL#:_____

INSULATION RESISTANCE	MEGOHMS	COMMENTS
MEASUREMENT		Corrected to 77^0 F (25^0 C). Minimum acceptable is 50 megohms.

HIGH POTENTIAL TESTS (With 500 volts DC)	SATISFACTORY? Yes	SATISFACTORY? No	COMMENTS
BAR-TO-BAR			
SHORT CIRCUIT BETWEEN: ♦Armature coils _____			
♦Armature coils and iron core			

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test Conductor			
USCG Inspector			

AMBIENT CONDITIONS:

APPENDIX B

OVERHAUL MAIN PROPULSION GENERATOR AND MOTOR ARMATURE AND FIELD WINDINGS

10. SCOPE

10.1 Scope. This appendix describes the requirements for the Contractor to overhaul main propulsion generator and motor armature and field windings.

20. REQUIREMENTS

20.1 Overhaul requirements. The Contractor shall accomplish the following:

20.1.1 Disassembly, cleaning, and inspection. Disassemble the machine; clean the commutator slots, using a combination of suction and a small bristle brush; wipe commutator and adjacent parts with a clean, lint-free canvas or cheesecloth. Perform the following inspection:

- Inspect commutator for signs of surface roughness, and for loose bars, high bars, movement of the mica, and cracked or broken risers.
- Record commutator diameter and eccentricity (if any).

20.1.2 Reassembly and tests. Reassemble the armature and accomplish the tests specified below. Record required test data on a DATA SHEET B-1 (Post-Cleaning and Inspection Tests) provided herein.

20.1.2.1 Bar-to-bar. Apply a test voltage of 500 volts D.C. between adjacent bars, to determine if any short circuit exists between armature coils and from armature coils to the iron core.

20.1.3 Component repair and renewal. Accomplish the following:

20.1.3.1 Armature and field winding insulation renewal. Re-insulate the armature and field windings, in accordance with manufacturer's recommendations, using materials in Table I (Insulation Materials for Random Windings), as applicable.

20.1.3.2 Commutator care. Performance maintenance on the commutator, in accordance with NSTM Chapter 300, Section 300-4.7.8 (Commutator Care).

20.1.4 Varnish treatment. Upon completion of component renewal and authorized repairs, accomplish solvent-varnish treatment of the armature and field windings by the dip and bake process, in accordance with the requirements of NSTM Chapter 300, Section 300-4.5.8.1 (Varnish Application) and the procedures shown in NSTM Chapter 300, Table 300-4-1 Varnishing Procedure (Solvent Varnish).

20.1.5 Armature assembly balancing.

20.1.5.1 Balancing requirements. Statically and dynamically balance the entire armature assembly, ensuring that the peak-to-peak displacement is at the motor's rated speed, when measured in accordance with NEMA MG-1, paragraph MG-1-23.51 or MG-1-24.50, does not exceed 0.003 inches.

20.1.5.2 Documentation. Record the added weights and their placements on DATA SHEET B-2 (Armature Assembly Balancing), provided herein. Submit the completed data sheet to the COR within 24 hours after balancing the armature assembly.

30 QUALITY ASSURANCE

No additional requirements.

40. NOTES

40.1 Field windings. The term "field windings" used herein applies to both main field and interpole field windings.

DATA SHEET B-1. POST-CLEANING AND INSPECTION TESTS

VESSEL NAME: _____

HULL#:_____

INSULATION RESISTANCE	MEGOHMS		COMMENTS
MEASUREMENT	SATISFACTORY?		Corrected to 77^0F (25^0C).
HIGH POTENTIAL TESTS	Yes	No	Test with 500 volts DC
Bar-to Bar			
Circuit between armature coils, and between armature coils to ground			

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test conductor			
USCG Inspector			
Ambient conditions:			

DATA SHEET B-2. ARMATURE ASSEMBLY BALANCING

VESSEL NAME: _____

HULL#:_____

	NAME (Type/Print)	**SIGNATURE**	**DATE**
Contractor			
USCG Inspector			
Ambient conditions:			

APPENDIX C

REBUILD MAIN PROPULSION GENERATOR AND MOTOR COMMUTATORS

10. SCOPE

10.1 Scope. This appendix describes the requirements for the Contractor to rebuild main propulsion generator and motor commutators.

20. REQUIREMENTS

20.1 General. The Contractor shall rebuild each commutator as described herein and ensure that it satisfies the post-overhaul requirements of this specification.

20.2 Rebuilding. The Contractor shall break the commutator riser connections and press the commutator off the armature shaft, to rebuild and test the commutator in accordance with NSTM Chapter 235, paragraph 235-5.22 (Recondition D.C. Armatures), and as follows:

20.2.1 Renew the commutator bars with bars manufactured from either hard-drawn, hard-rolled, or drop-forged copper. Configure the new bars similarly to the (removed) existing bars except the bars shall be thick enough to achieve a finished commutator diameter equal to the manufacturer's original diameter.

20.2.2 Renew the commutator ground insulation and the V-ring insulation using pasted mica, type PMM conforming to ASTM D352. The thickness and the extent of the ground and V-ring insulation installed shall be equal, as a minimum, to the thickness and extent of the original insulation removed.

20.2.3 Renew the commutator segment insulation using pasted mica, Type PMR, conforming to ASTM D3527. The thickness and the extent of the segment insulation installed shall equal the thickness and extent of the segment insulation removed.

20.2.4 Manufacture the new commutator riser from hard-drawn copper conforming to ASTM B272.

20.2.4.1 Configure the new risers similarly to the (removed) existing risers, with the exception that the width of the vertical riser necks (front face to back face) shall be one inch nominal.

20.2.4.2 Tin the riser necks and silver braze the risers to the commutator segments. Tungsten inert gas (TIG) weld the riser connections instead of silver braze, if the original connection is made by TIG weld. Ensure that all risers are the same height.

20.2.5 Renew the string bands (commutator front and back V-ring extensions) with glass banding tape conforming to MIL-I-24178.

20.2.6 Torque the commutator holding bolts to the manufacturer's recommendations to ensure the bars will not move.

20.2.7 Correct high bars, mica movement, and cracked or broken risers in accordance with NSTM Chapter 235, Section 235-5.22 (Recondition D.C. Armatures).

20.2.8 Machine the commutator outside diameter to be concentric with the mounting sleeve inside diameter to within 0.004 inch total indicated run out.

20.2.9 Grind the commutator using first a finishing stone and then a polishing stone. Finish the job after polishing by either burnishing the commutator with oak to a cocoa-brown finish or by holding fine grade sandpaper against the commutator while turning.

20.2.10 Undercut and chamfer the commutator in accordance with NSTM Chapter 300, sections 4.7.8.8 through 4.7.8.8.5.

20.2.11 After machine work, balance the commutator to a residual imbalance point of 15 gram-inches or less.

20.3 Inspections.

20.3.1 The Contractor shall carefully examine and record deficiencies for the rebuilt commutator, and accomplish the following, as necessary:

20.3.1.1 Ensure the commutator eccentricity does not exceed 0.004 inch.

20.3.1.2 Ensure the axial skew at the commutator bars does not exceed 0.010 inch from the front end to the back end of the bars.

20.3.1.3 Ensure the final diameter is in accordance with the original manufacturer's specifications.

20.3.1.4 Adjust the string band tension to a maximum of 600 foot-pounds.

20.3.2 Perform the tests and inspections outlined in paragraph 30.3 (Tests), before, connecting the commutator to the windings.

20.4 Season curing of reconstructed commutator. After reinstallation of propulsion equipment, the Contractor shall season (cure) the reconstructed commutator with sufficient commutator bolt torque cycles to ensure the commutator bars will not change position under normal operation. Include rated loads in the seasoning process while rotating the commutator. Start with 25 percent load for two hours; increase the load by 10 percent increments every hour until full load is reached and then operate the generator and motor at full load for four hours.

30. QUALITY ASSURANCE

30.1 Tests. The Contractor shall perform the following tests and provide documented test data for the reconstructed commutator to establish that the following acceptance criteria have been satisfied. Record the required test data on a copy of DATA SHEET C-1 (Main Generator and Motor Commutator Checklist) provided herein.

30.1.1 Bar-to-bar A.C. high potential test. Connect a 60 Hz A.C. high potential test source to each pair of adjacent commutator bars. Rapidly increase the test voltage from zero to 400 volts A.C. and maintain this voltage for one minute. Decrease the test voltage smoothly at a rate of 20 volts per second to zero.

30.1.2 Bar-to-shaft high potential test. Wrap several turns of bare copper wire securely around the commutator. Connect one terminal of the high potential source to the bare copper wire and the other terminal of the high potential source to the armature shaft. Rapidly increase the test voltage from zero to 1250 volts A.C. and maintain this voltage for one minute. Decrease the test voltage smoothly at a rate of 175 volts per second to zero.

30.1.3 Insulation resistance. Ensure the insulation resistance to ground with all commutator bars connected together is at least 100 megohms (corrected to 25 degrees Celsius) with an applied voltage of 500 volts D.C. Take insulation resistance to ground measurements before and after A.C. high potential testing.

40. NOTES

This section is not applicable to this appendix.

DATA SHEET C-1. MAIN GENERATOR AND MOTOR COMMUTATOR CHECKLIST

SEQ	TEST	MEASUREMENT	UNITS
A	INSULATION RESISTANCE		Megohms
B	HIGH POTENTIAL TESTS BAR-to-BAR		Micro-ohms
C	BAR-to-SHAFT		Micro-ohms
D	INSULATION RESISTANCE		Megohoms
E	RUN OUT (Total indicated)		Thousandth-inch
F	AXIAL SKEW		Thousandth-inch
G	RESIDUAL IMBALANCE		Gram-inch

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test Conductor			
USCG Inspector			
AMBIENT CONDITIONS:			

APPENDIX D

REWIND MAIN PROPULSION GENERATOR AND MOTOR ARMATURES

10. SCOPE

10.1 Scope. This appendix describes the requirements for rewinding main propulsion generator and motor armatures.

20. REQUIREMENTS

20.1 General. The Contractor shall rewind each main propulsion generator and motor armature as described herein so that it satisfies the post-overhaul requirements of this specification.

20.1.1 Material. Overhaul and reinsulate the armature and field windings using materials complying with Table I (Insulation Materials for Random Windings Insulation Materials) as applicable; furnish a list, before commencing work, describing each material to be used, where the material will be used, and to which standard the material conforms.

20.1.2 Inspection and test notification and documentation. Abide by the following requirements for all inspections and tests specified herein.

20.1.2.1 Advance notice. Notify the Coast Guard Inspector at least 24 hours before performing each inspection and test.

20.1.2.2 Documentation. Submit a CFR, upon completion of each inspection and test, in addition to a copy of completed test data sheet.

20.2 Rewind. The Contractor shall rewind the armature as follows:

20.2.1 Remove the commutator from the armature shaft and keep accurate records of all connections.

20.2.2 Strip all windings and insulation from the armature; keep accurate records of coil data, size and type of wire, number of turns, slot spacing, coil shape, equalizer connections, and riser connections.

20.2.3 After removing all windings, clean the entire core to remove all existing varnish, grease, rust, corrosion, and any other foreign matter from the spider, all ventilating slots, winding slots, and exterior laminations.

20.2.4 Observe the following practices when stripping wound components and cleaning the core:

WARNING!

Do not use the following on laminated iron surfaces:
- **Open flame.**
- **Torch.**
- **Sand.**
- **Grit.**

20.2.4.1 If solvent stripping (other than vapor degreaser) is used, ensure by inspection that the solvent has neither damaged the core plate nor been retained or trapped between laminations.

20.2.4.2 The maximum surface temperature of the laminated iron surface shall not exceed 370 degrees Celsius (698 degrees Fahrenheit).

20.2.4.3 Very light abrasive blasting with organic materials or glass beads may be used to clean laminated surfaces. In any case, do not damage the laminated surfaces by the abrasive used.

20.2.5 Remove all varnish and insulating materials from the slots and all varnish accumulation on the shaft, coil support rings, spider, rotor ID (Internal Diameter), and other surfaces. Ensure all air passages, vents, and holes are clean and free of old varnish and other material.

20.3 Testing. The Contractor shall verify the condition of the laminate insulation in the armature core by conducting a core iron loop test for three to four hours on the stripped generator and motor armature as follows and record the required test data on a copy or facsimile of DATA SHEET D-1 (Core Iron Loop Test) provided herein.

20.3.1 Perform the loop test using the actual volts per turn in the stator windings to produce the core density (kilolines per square inch).

20.3.2 As a general rule, hot spots require attention if they surpass 12 degrees Celsius (53.6 degrees Fahrenheit) above the average steady state readings. Therefore, if the core temperature limit (12 degrees Celsius) is exceeded during the test, repair the core as follows:

20.3.2.1 Unstack the armature core iron.

20.3.2.2 Reinsulate the armature core laminations.

20.3.2.3 Restack the armature core iron.

20.3.2.4 Conduct a core iron loop test on the restacked core to verify satisfactory condition of the laminate insulation.

20.4 Shaft run out. Before installing new windings, the Contractor shall:

20.4.1 Measure and record the armature shaft run out using NSTM Chapter 235, Section 235-5.22 (Reconditioning D.C. Armatures) as a guide.

20.4.2 Advise the COR before proceeding with any other work on this armature if the run out exceeds the parameters given in Table D-I for four 90-degree locations around the perimeter.

20.4.3 Record the required test data for the shaft run out parameters for the generator and motor armature on a copy or facsimile of DATA SHEET D-2 (Armature Checklist) provided herein.

TABLE D-I. SHAFT RUN OUT PARAMETERS

DETAIL	TOLERENCE (±inch)
Journal run out	0.0025
Run out between the journal and armature	0.010
Perpendicularity between the journal and shaft coupling	0.001

20.5 Nondestructive testing. The Contractor shall conduct non-destructive testing of the shaft for cracks and flaws, using either the ultrasonic (UT), magnetic particle (MT), or liquid penetrant (PT) inspection method. UT inspect in accordance with ASTM E114 and ASTM E587. MT inspect in accordance with ASTM E709 and ASTM E1444. PT inspect in accordance with ASTM E165 and ASTM E1417. Submit a CFR.

20.6 Bearing journal restoration. The Contractor shall restore the bearing journal(s) to their original diameter as follows:

20.6.1 Chrome plate the bearing journals in accordance with ASTM B177.

20.6.2 Record the depth of metal machined from the journal

diameter before buildup. Advise the Coast Guard Inspector before proceeding if machining deeper than 0.025 inches.

20.6.3 Apply the buildup metal so that it will not flake or crack under normal operating conditions.

20.6.4 Polish all journal areas after completing buildup metal process.

20.7 Records. The Contractor shall keep accurate records of work performed on the armature shaft, and submit a report to the COR within 24 hours after taking the measurements required herein.

20.8 Light varnish treatment. The Contractor shall treat the entire core with a light coat of varnish (20 percent solution) conforming to MIL-I-24092, Class 155, Grade CB, Composition I varnish, ensuring a smooth even coat.

20.9 Reinstallation. The Contractor shall reinstall the removed commutator onto the armature shaft.

20.10 Rewinding. The Contractor shall rewind the armature and insulate, using all new Class F materials as shown in Table D-I to neither reduce the designed durability factor and performance nor change the manufacturer's original electrical and mechanical characteristics.

20.10.1 Banding. Ensure the armature banding is as original and meets magnetic and non-magnetic required characteristics as original manufacture.

20.10.2 Tests. Before connecting the commutator to the armature windings, perform the following tests and record the required data on a copy of DATA SHEET D-3 (Armature Electrical Tests) provided herein:

20.10.2.1 Insulation resistance. Perform an insulation resistance test before and after the D.C. high potential test (see 20.10.2.2 (D.C. high potential)) in accordance with NSTM Chapter 300, Section 300-3.4.11 (Insulation Resistance as a Guide in Overhaul). An insulation resistance of 50 megaohms corrected to 77 degrees Fahrenheit (25 degrees Celsius) is the minimum acceptable.

20.10.2.2 D.C. high potential. Perform a D.C. high potential test in accordance with NSTM Chapter 300, Section 300-3.5.2 (Test Procedure Instructions).

20.10.3 Vacuum pressure impregnate (VPI). Vacuum pressure impregnate (VPI) the rewound armature as follows:

20.10.3.1 VPI the windings using 100 percent solid epoxy varnish; verify that the thixotropy index, viscosity, and percent solids are within the acceptable limits for the epoxy resin used in accordance with MIL-I-24092.

20.10.3.2 Preheat the windings to 302 degrees Fahrenheit (150 degrees Celsius) for at least three hours.

20.10.3.3 Cool the windings to 140 degrees Fahrenheit (60 degrees Celsius) maximum.

20.10.3.4 Place the windings in a heating tank and evacuate for at least 15 minutes. Time starts when a vacuum of five mm Hg is obtained. Permit the vacuum to go as low as possible during this period. Maintain vacuum until the temperature reaches 130 degrees Fahrenheit (54 degrees Celsius).

20.10.3.5 Bring the impregnating resin, while maintaining the temperature at 68 degrees Fahrenheit (20 degrees Celsius) plus or minus five degrees C, into the treating tank under vacuum and cover the entire windings with resin. Continue to evacuate until bubbling stops.

20.10.3.6 Apply a 40 to 90 psig nitrogen blanket to the tank until the unit cools to 90 degrees Fahrenheit (32 degrees Celsius plus or minus one degree C) and maintain this pressure for at least 30 minutes.

20.10.3.7 Transfer the resin to the storage tank. Remove the windings and allow them to drain until dripping stops. Wipe excess resin from the winding base and remove any drips. Drain with the connection end down.

20.10.3.8 Place the windings in an oven at 302 degrees Fahrenheit (150 degrees Celsius) and remove any drips and icicles after one hour.

20.10.3.9 Bake the windings for four hours after the laminations reach a surface temperature of 302 degrees Fahrenheit (150 degrees Celsius).

20.10.3.10 Drain windings vertically with the connection end up.

20.10.4 Post-VPI Electrical tests. After the VPI treatment, conduct the following tests and record the data on a copy or facsimile of DATA SHEET D-3 (Armature Electrical Tests) provided herein.

20.10.4.1 Bar-to-bar. Apply a test voltage of 500 volts D.C. between adjacent bars to determine if any short circuit exists between the armature coils or between the armature coils and the iron core.

20.10.4.2 Insulation resistance. Perform an insulation resistance test before and after the D.C. high potential test (see 20.10.4.4) in accordance with NSTM Chapter 300, section 300-3.4.11 (Insulation Resistance as a Guide in Overhaul). An insulation resistance of 50 megohms corrected to 77 degrees Fahrenheit (25 degrees Celsius) is the minimum acceptable.

20.10.4.3 Surge comparison. Perform a voltage surge comparison test in accordance with NSTM Chapter 300, Section 300-3.5.4 (Voltage Surge Comparison Test).

20.10.4.4 D.C. high potential. Perform a D.C. high potential test in accordance with NSTM Chapter 300, Section 300-3.5.2 (Test Procedure Instructions).

20.10.4.5 Insulation resistance. Perform an insulation resistance test after the D.C. high potential in accordance with NSTM Chapter 300 Section 300-3.4.11 (Insulation Resistance as a Guide in Overhaul).

20.10.5 Varnish treatment. After the VPI process, varnish treat the rewound armature in accordance with NSTM Chapter 300, Table 300-4-1 (Varnish Procedure).

20.10.6 Silver braze. After the VPI and varnish treatments silver braze all connections from equalizers (cross-connectors) to coil and from coil to commutator riser.

20.10.6.1 Use this method even though the original installation may have been made with tin or tin-alloy solders.

20.10.6.2 TIG (Tungsten Inert Gas) weld the above connections instead of silver braze if the original connection is made by TIG weld.

20.11 Balancing. The Contractor shall accomplish the following:

20.11.1 Statically and dynamically balance the entire rewound armature.

20.11.2 Ensure the peak-to-peak displacement at the motor's rated speed, when measured in accordance with NEMA MG-1, paragraph MG-1-23.51 or MG-1-24.50, does not exceed 0.003-inch.

20.11.3 Use a copy or facsimile of DATA SHEET D-4 (Armature Balancing) provided herein to record the added weights and their placement.

20.11.4 Submit the completed data sheet to the COR within 24 hours after balancing the armature assembly.

20.12 Final acceptance. Final acceptance shall be on the vessel with the propulsion generators and motor fully functional and after satisfactory sea trials and temperature-corrected megger readings.

30. QUALITY ASSURANCE

No additional requirements.

40 NOTES

This section is not applicable to this specification.

DATA SHEET D-1. CORE IRON LOOP TEST

WIRE SIZE		NUMBER OF TURNS	TEMPERATURE (Degree Celsius)			
DURATION	VOLTAGE	CURRENT	HOT SPOTS			COLD
(second)			1	2	3	SPOT

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test Conductor			
USCG Inspector			
AMBIENT CONDITIONS:			

DATA SHEET D-2. ARMATURE CHECKLIST

LOCATION	MAXIMUM (inch)	MEASUREMENTS 90-DEGREE INTERVALS 1	2	3	4
Journal(s) Diameter	0.0025				
Journal(s) and Shaft	0.010				
Perpendicularity Journal and Shaft Coupling	0.001				

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test Conductor			
USCG Inspector			
AMBIENT CONDITIONS:			

DATA SHEET D-3. ARMATURE ELECTRICAL TESTS

TEST	READINGS*		COMMENTS/UNITS
	Satisfactory		
	Yes	No	
Bar-to-Bar			a) Between armature coils
			b) Between armature coils to iron core
INSULATION RESISTANCE	*		Megaohms
SURGE COMPARISON**			Volts per second
D.C. HIGH POTENTIAL	*		Microamperes
INSULATION RESISTANCE	*		Megaohms

***Before VPI Process.**
****Check if satisfactory.**

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test Conductor			
USCG Inspector			
AMBIENT CONDITIONS:			

DATA SHEET D-4. ARMATURE BALANCING

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
USCG Inspector			
AMBIENT CONDITIONS:			

APPENDIX E

REWIND MAIN PROPULSION GENERATOR AND MOTOR MAIN FIELD WINDINGS

10. SCOPE

10.1 Scope. This appendix describes the requirements for rewinding main propulsion generator and motor main field (i.e., shunt, series and compensating) windings.

20. REQUIREMENTS

20.1 General. The Contractor shall rewind each main propulsion generator and motor main field windings as described herein to satisfy the post-overhaul requirements of this specification.

20.1.1 Notification. Record and notify the Coast Guard Inspector of any condition that requires corrective action during the overhaul process.

20.1.2 Material. Rewind the main field windings using materials complying with Table I as applicable for Random Wound Motor Windings Insulation Materials. Furnish a list describing each material used, where the material was used, and to which standard the material conforms.

20.1.2.1 Tests and inspections.

20.1.2.2 Advance notice. Notify the Coast Guard Inspector at least 24 hours before performing each test and inspection required herein.

NOTICE

The Coast Guard reserves the right to witness tests on a random basis as deemed necessary.

20.1.2.3 Documentation. Submit a CFR for all inspections.

20.2 Rewind main field windings. The Contractor shall rewind and test the main field windings as follows:

20.2.1 Remove and discard the main field windings including shunt, series, and compensating windings from the pole piece.

20.2.2 High pressure water clean the pole piece using a cleaning solution, consisting of liquid non-ionic water-soluble general purpose detergent, conforming to MIL-D-16791 (in a proportion of 1 ounce to 1 gallon of fresh water heated to 130^0 to 150^0 F.) in accordance with NSTM 300-4.5.5 (High-Pressure Water Spray).

20.2.3 Remove old varnish from the pole piece and bake either for eight hours or more until dry.

20.2.4 Renew the shunt, series and compensating windings with new material and rewind each new main field winding directly onto the pole piece, using all new class F insulating material in accordance with Table I herein. Each coil shall be identical to each other in all respects and retain the original designed capability, durability, and resistance to external elements.

20.2.5 Ensure the winding resistance of each shunt, series, and compensating field winding is within plus or minus two-and-one-half percent of either the original manufacturer's specification at 167 degrees Fahrenheit (75 degrees Celsius) or if unavailable the measured resistance of each component. Notify the COR if the measured resistance readings are not within this range.

20.3 Vacuum pressure impregnate. The Contractor shall vacuum pressure impregnate (VPI) the rewound main field windings as follows:

20.3.1 VPI the windings using 100 percent solid epoxy varnish; verify that the thixotropy index, viscosity, and percent solids are within the acceptable limits for the epoxy resin used in accordance with MIL-I-24092.

20.3.2 Preheat the windings to 302 degrees Fahrenheit (150 degrees Celsius) for at least three hours.

20.3.3 Cool the windings to 140 degrees Fahrenheit (60 degrees Celsius) maximum.

20.3.4 Place the windings in a heating tank and evacuate for at least 15 minutes. Time starts when a vacuum of five mm Hg is obtained. Permit the vacuum to go as low as possible during this period. Maintain the vacuum until the temperature reaches 129 degrees Fahrenheit (54 degrees Celsius).

20.3.5 While maintaining the temperature at 68 degrees Fahrenheit (20 degrees Celsius) plus or minus five degrees, bring the impregnating resin into the treating tank under vacuum; cover the entire windings with resin. Continue to evacuate until bubbling stops.

20.3.6 Apply a 40 to 90 psig nitrogen blanket to the tank until the unit cools to 90 degrees Fahrenheit (32 degrees Celsius) plus or minus one degree and maintain this pressure for at least 30 minutes.

20.3.7 Transfer the resin to the storage tank; remove the windings and allow them to drain until dripping stops. Wipe excess resin from the winding base and remove any drips. Drain with the connection end down.

20.3.8 Place the windings in an oven at 302 degrees Fahrenheit (150 degrees Celsius) and remove any drips and icicles after one hour.

20.3.9 Bake the windings for at least four hours after the laminations reach a surface temperature of 302 degrees Fahrenheit (150 degrees Celsius).

20.3.10 Drain the windings vertically with the connection end up.

20.4 Electrical tests. The Contractor shall perform the following tests on the rewound main field windings and record the data on a copy of DATA SHEET E-1 (Rewound Main Field Windings Electrical Tests) provided herein.

20.4.1 Insulation resistance. Use 500 volts D.C. for the test voltage. An insulation resistance of 50 megohms, corrected to 77 degrees Fahrenheit (25 degrees Celsius) is the minimum acceptable.

20.4.2 Winding resistance. Measure the winding resistance using a micro-ohmmeter.

20.4.3 D.C. high potential. Test voltage shall be 1.6(2E+1000) where E is the machine's rated voltage.

20.4.4 Surge comparison. The maximum test voltage shall be in accordance with NSTM Chapter 300, Section 300-3.5.4, Voltage surge comparison test.

20.4.5 Voltage drop. The test voltage to determine voltage drop shall be 500 volts D.C.

20.5 Varnish treatment. The Contractor shall varnish the main field windings in accordance NSTM Chapter 300, Table 300-4-1 (Varnish Procedure).

20.6 Final acceptance. Final acceptance by the Coast Guard Inspector shall be on the vessel with the propulsion generators and/or motor fully functional and after satisfactory sea trials

and temperature-corrected megger readings.

30. QUALITY ASSURANCE

No additional requirements.

40. NOTES

This section is not applicable to this appendix.

DATA SHEET E-1. REWOUND MAIN FIELD WINDINGS ELECTRICAL TESTS

POLE	T E S T				
	*INSULATION RESISTANCE (Megohms)	WINDING RESISTANCE (ohms)**	SURGE COMPARISON ***	D.C. HIGH POTENTIAL ***	VOLT DROP (volts)
1					
2					
3					
4					
5					
6					
7					
8					

***Corrected to 25 degrees Celsius.**
****At 75 degrees Celsius.**
*****Check if satisfactory.**

	NAME (Type/Print)	SIGNATURE	DATE
Contractor			
Test Conductor			
USCG Inspector			
AMBIENT CONDITIONS:			